RETAIL STORAGE OF PEELED, HARD-BOILED WHOLE EGGS

Péter Ozsváth [a], Csaba Németh[a], László Friedrich[a], Klára Pásztor-Huszár[a], Zoltan Németh[b], Kinga Horváth[a], Csilla Vén[a], Csaba Balla[a]*

[a]Corvinus University of Budapest, Faculty of Food Science, Department of Refrigeration and Livestock Products Technology, Budapest, H-1118, Ménesi út 43-45, Hungary

[b]Faculty of Agricultural and Environmental Sciences, Institute of Botany and Eco-Physiology Gödöllő, H-2100, Páter Károly út. 1.

e-mail: csaba.nemeth@uni-corvinus.hu

ABSTRACT

The use of peeled hard-boiled whole eggs is widespread in the industry; however its retail trade is hindered by many factors. The most important is the complicated preservation of egg which due to its complex composition is an excellent medium for micro-organisms. Maintaining the colour, taste and aroma characteristic of fresh, boiled eggs during storage generates further problems. In our study we searched for a packaging method that ensures the safe home cool storage of peeled hard-boiled whole eggs and keeps egg quality. In our experiments the peeled hard-boiled whole eggs were vacuum-packed, packed into protective gas or stored at cool temperature after immersing them in salty, with citric acid acidified liquid. Having examined the changes during cool storage in the samples packed in various ways we found that if a product with shorter shelf-life is satisfactory, the use of protective atmosphere is advisable. However when it is necessary to ensure the shelf-life longer than 14 days, this could be achieved by eggs stored in acidified brine.

1. INTRODUCTION

In these days cold kitchens and restaurants prefer to use peeled hard-boiled whole eggs instead of raw shell eggs (Stadelman & Cotterill, 1995). The reason is that hard-boiled eggs are homogenous in quality and in appearance, are easy to use and are free from the strongly faeces-contaminated shell, which means food safety risk (Moats, 1980). Further advantage is that during cooking at a temperature higher than 90°C (Hale et al, 1981) most of the heat-sensitive bacteria (Adams & Moss, 1995) in eggs causing deterioration are destroyed (Stadelman et al., 1982) as well as *Salmonella* that possesses similarly low thermal resistance (Jin et al., 2008).

In spite of their advantageous properties peeled hard-boiled whole eggs cannot be purchased from retail trade, they are only available in packaging intended for big consumers (60-90 pc/pack). However the changes in consumer demands, through the increased use of convenience foods, have brought the development of boiled egg products which are quick and ease of use in the households into limelight (Stadelman et al, 1988).

Important criteria for peeled hard-boiled whole egg getting into retail are to maintain the advantageous properties of fresh product, to be easy to store as well as to be suitable from food safety point of view (Harrigan & Park, 1991).

One option for retail of hard-boiled eggs is their storage in salty water with reduced pH, similarly to products intended for further industrial processing. In such a „brine" even a pH value of about 4,5 can be adjusted to inhibit bacterial agents (McMeekin et al., 1993) i.e. the pickled product keeps its harmonious taste due to the added salt.

The other possibility is the storage of hard-boiled eggs in modified atmosphere or vacuum packaging. According to literary data the shelf-life of peeled hard-boiled whole

eggs can be significantly extended in a CO_2 containing atmosphere for the reason that eggs release CO_2 more slowly (Feiser & Cotterill, 1982), thus their acidity decreases to a lesser extent during storage (Brooks & Pace, 1938). Beside keeping quality the oxygen-free packaging either by modified atmosphere or by vacuum inhibits the multiplication of aerobe micro-organisms (Prescott et al, 1993).

In our research hard-boiled egg products in retail packages were stored in refrigerator at 4°C and microbiological, pH, sensory and colour examinations were carried out to determine changes during storage.

2. MATERIALS AND METHODS

Fresh eggs were purchased from a Hungarian egg producer. The eggs were boiled for 10 minutes at 95 °C, then shells were removed manually using sterile gloves. The peeled hard-boiled whole eggs were put into vacuum or gas (50-50% N_2 and CO_2) packaging or to a container filled up with 1% salt solution acidified to pH 4,5 by citric acid. The eggs packaged in various ways were refrigerated at 4°C in the same way (Stadelmanet al, 1982).

Viable cell counts were measured in triplicate and the presence of *Salmonella* was monitored on selective culture media weekly. In the case of *Salmonella* detection the peeled hard-boiled eggs were homogenized and 25 g of them was enriched on Rappaport selective medium for 24 hours after a 24-hours peptone water pre-enrichment. Subsequently streaking was carried out on bismuth-sulfite, BPL and XLD selective media. Incobution were carried out in the case of the viable cell counts determination for 48 hours at 30°C, and in the case of *Salmonella* detection for 48 hours at 37°C.

The pH value of eggs was tested weekly. It was carried out by SENTRON pH meter, with insertion pH electrodes, excellently suitable for testing hard-boiled eggs. In every case measurements were made at 3 different points in triplicate.

Colour tests were achieved by Minolta ChromaMeter CR-200 type colorimeter suitable for tristimulus reflexive colour measurement and also 3 samples were examined at 3 points weekly.

Sensory analyses were made to carry out a group of 15 people of variable age and gender. The questioned properties were taste, odour and texture on a ten graded scale, where 10 meant the characteristic sense of a fresh, hard-boiled egg, while 1 referred to a totally different sense from this. Tasting was carried out only in case of acceptable microbiological results.

3. RESULTS

The bactericide effect of the various storage methods may be different due to the pH value developing in the eggs. While vacuum and protective gas packaging influences the pH value of samples only to a small degree, the acidified salty water quickly and significantly modified it.

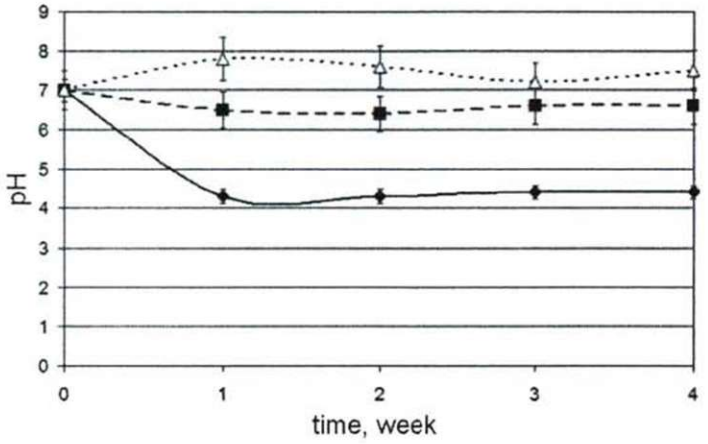

Figure 1. Change in pH values of hard-boiled eggs

♦ Hard-boiled whole eggs in salty liquid, ■ Hard-boiled whole eggs in protective gas, △ Hard-boiled whole eggs in vacuum

Figure 1 shows that while the pH values of vacuum-packed samples slightly increased that of samples packed into protective gas in fact remained unchanged.

In the case of vacuum packed samples the slight rise in pH values was probably due to the release of CO_2 resulted from the dissociation of carbonic acid. This process was inhibited by the protective gas with a 50 % of CO_2 concentration which prevented carbonic acid from dissociation.

Eggs stored in acidified brine adopted its pH value at the end of the first week, and pH remained unchanged during our experiments.

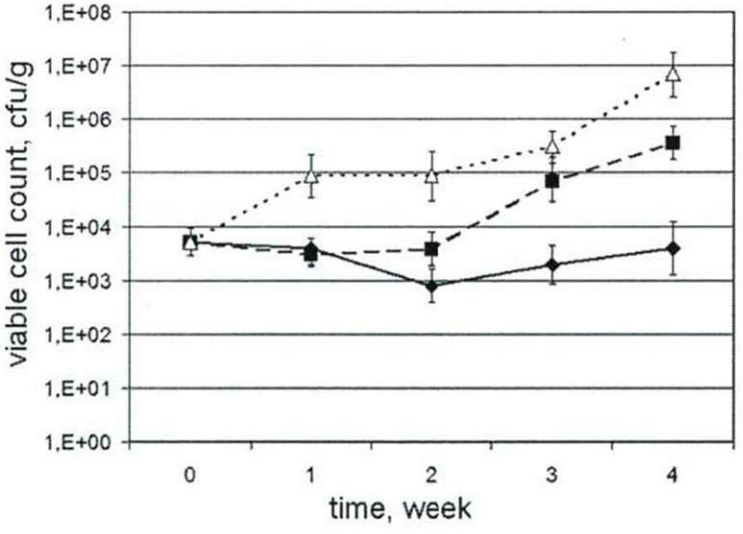

Figure 2. Change in viable cell counts of hard-boiled eggs

♦ Hard-boiled whole eggs in salty liquid, ■ Hard-boiled whole eggs in protective gas, △ Hard-boiled whole eggs in vacuum

As it can be seen from Figure 2 the fastest increase in viable cell counts was in the case of vacuum-packed cool stored hard-boiled whole eggs. In these samples even in the 1st week about 10^5 cfu/g value was measured, which is the food safety limit related to egg products.

In samples stored in salty, pH-reduced liquid or protective gas no significant increase in viable cell counts was found up to the second week. Subsequently the viable cell counts of eggs stored in protective gas increased relatively quickly.

The changes in viable cell counts of eggs stored in acidified brine remained insignificant during our examinations, and at the end of the experiment the value obtained in these samples was similar to the initial one.

During the 3 weeks of the experimental storage time no *Salmonella* was detected in any of the samples packed in the various ways.

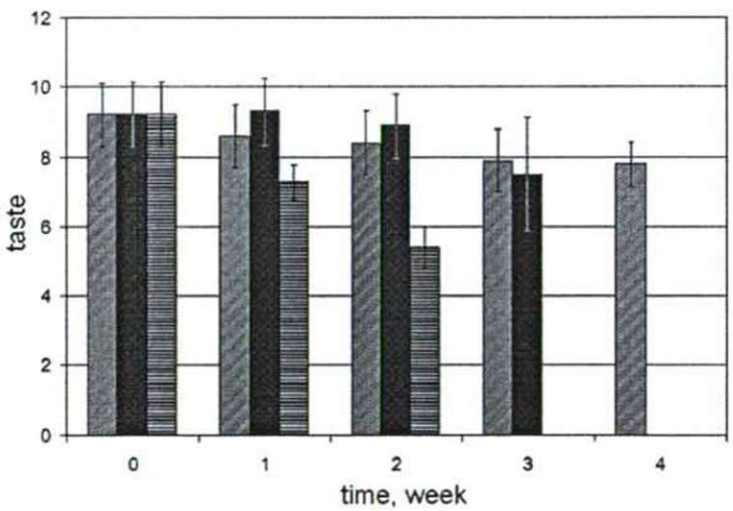

Figure 3. Tendencies in taste of hard-boiled egg
Hard-boiled whole eggs in salty liquid, Hard-boiled whole eggs in protective gas, Hard-boiled whole eggs in vacuum

From Figure 3 it can be concluded that up to the 2nd week the taste of cool stored, hard-boiled, peeled whole eggs packed in protective gas (50-50% N_2 and CO_2) was the most adequate according to the tasters. However between the 2nd and the 3rd week relatively large deterioration in taste could be observed. In the fourth week tasting were not carried out due to the microbiological risk.

In the eggs stored in acidic salty liquid from the second week a relatively small change in taste was found. The only exception was the slightly acidic effect in taste. However when the eggs stored in salty liquid were used according to the intended

application method (egg salad, slice into sandwich) the tasters could not distinguish fresh and stored eggs.

The taste of vacuum packed, peeled, hard-boiled eggs was the least favourable, it degraded even to the second week.

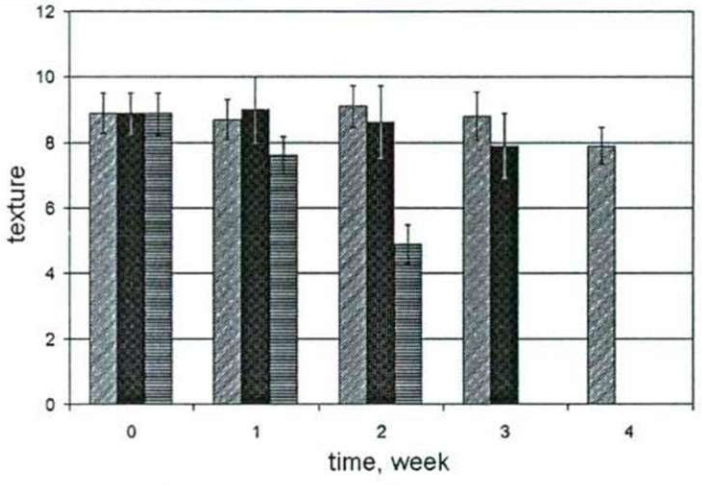

Figure 4. Change in the texture of boiled eggs

Hard-boiled whole eggs in salty liquid, Hard-boiled whole eggs in protective gas, Hard-boiled whole eggs in vacuum

The texture of eggs stored cool in acidified brine remained unchanged up to the first three weeks, only to the fourth week deteriorated to some extent according to the tasters (Figure 4). The texture of eggs stored in protective gas packaging also showed favourable tendency. The texture of vacuum-packed eggs deteriorated quickly and from the second week an unpleasant texture was found at consumption.

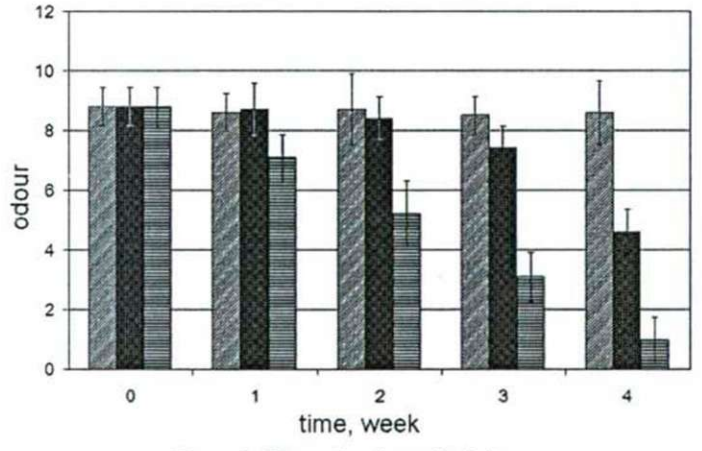

Figure 5. Change in odour of boiled eggs

Hard-boiled whole eggs in salty liquid, Hard-boiled whole eggs in protective gas, Hard-boiled whole eggs in vacuum

The characteristic odour of peeled, hard-boiled, whole eggs (Figure 5) was particularly maintained in the acidified salty liquid. Applying this storage method the samples maintained the odour of fresh, hard-boiled eggs during our experiments.

During the first two weeks of storage the odour of eggs stored in protective gas compared with that of samples stored in salty liquid showed similar favourable tendency. In the second week samples stored in CO_2-N_2 gas mixture possessed approximately identical "smell-attributes" than freshly boiled eggs. Subsequently, however, significant change occurred in odour, which can probably be justified by the change in microbiological status.

The odour of vacuum-packed eggs significantly changed even in the first two weeks of storage and for the last two weeks of our experiments these samples particularly smelled as a "rotten egg".

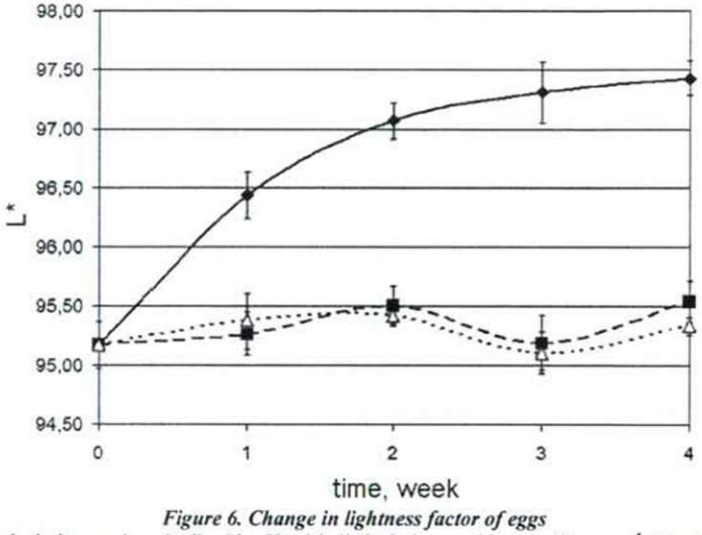

Figure 6. Change in lightness factor of eggs
♦ Hard-boiled whole eggs in salty liquid,■ Hard-boiled whole eggs in protective gas, △ Hard-boiled whole eggs in vacuum

Figure 6 shows that while in terms of extent and progress similar changes occurred in the surface of both vacuum packed and protective gas packaged products concerning the lightness factor (L*), of eggs stored in salty liquid difference was found.

These differences could be observed even in the first week. The surface of eggs slightly, perceptible with senses faded in salty liquid. These changes however did not give an unpleasant impression about eggs stored in salty liquid.

4. DISCUSSION

Our results show that vacuum packed eggs not just have a short shelf-life but quickly loose sensory attributes characteristic of fresh hard-boiled eggs.

Sensory attributes of samples stored in both acidified salty liquid and in protective gas packaging were more favourable. The taste and colour of eggs stored in N_2-CO_2 gas

mixture were more favourable during the 1st two weeks, but their shelf-life proved to be significantly shorter taking into account relevant food safety and quality criteria. While the total plate count of peeled, hard-boiled, whole eggs in the case salty, with citric acid acidified water of in terms of the order of magnitude remained the same all along our experiments, the samples stored in protective gas packaging deteriorated up to the fourth week.

According to our studies the hard-boiled eggs packaged in protective gas is recommended for such consumers (small shops, buffets), who consider the natural colour of eggs important or their stock changes quickly. When hard-boiled eggs are used for further processing or they can be to stored for longer time it is advisable to select storage in acidified salty liquid.

REFERENCES

1. Adams, M. R., Moss, M. O. (1995): Chapter 7: Food Microbiology, Bacterial Agents of Foodborn Illnesses, The Royal Society of Chemistry.
2. Brooks, J., Pace, J. (1938): The distribution of carbon dioxide in the hen's egg, Proc. Royal. Soc. London, Ser.B. 126,196-210.
3. Feiser, G.E., Cotterill, O.J. (1982): Composition of serum from cooked-frozen-thawed-reheated scrambled eggs at various pH levels, J. Food. Sci., 47, 1333-1337.
4. Hale, K.K., Potter, L.M., Martin, R.B. (1981): Firmness and microbial quality of hard-cooked eggs stored in critic acid, Pult. Sci. 60, 1664.
5. Harrigan, W.F., Park, R.W.A. (1991): Making safe food, Academic Press, London.
6. Jin, T., Zhang, H., Boyd, G., Tang, J. (2008): Thermal resistance of Salmonella enteritidis and Eschericha coli K12 in liquid egg determined by thermal-death-time disk, Journal of Food Engineering 84, 608-614.
7. McMeekin, T.A., Olley, J.N., Ross, T., Ratkowsky, D.A. (1993): Predictive Microbiology, Research Studies Press Ltd., Taunton.
8. Moats, W.A. (1980): Classification of bacteria from commerical egg washers and washed and unwashed eggs, Appl. Environ. Microbiol., 40,710-714.
9. Prescott L.M., Harley J.P., Klein D.A. (1993): Microbiology, Chapter 15: Control of Microorganisms by Physical and Chemical Agents, WCB Publishers.
10. Stadelman, W.J., Cotterill, O.J. (1995): Egg science and technology, Food Product Press.
11. Stadelman, W.J., Ikeme, A.I., Roop, R.A., Simmons, S.E. (1982): Thermally processed hard cook eggs, Poult. Sci. 38, 1253-1254.
12. Stadelman, W.J., Olson, V.M., Shemwell, G.A., Basch, S., (1988): Egg end Poulty Meat Processing, Ellis Horeood Ltd, Chichester, England.
13. Stadelman, W.J., Ikema, A.I., Roop, R.A., Simmons, S.E. (1982): Thermally processed hard-cooked eggs, Poult. Sci. 61, 388-391.